Recent Research – TRB Compendium of Papers 2006

Bridge Integrated Analysis and Decision Support: Case Histories
WHRP Project 0092-04-15

The paper(s) abstracted below report recent research that may be related to the subject matter or methodologies of this WHRP project. For access to the CD-ROM and full text of the paper, contact Hussain Bahia (bahia@engr.wisc.edu) or Greg Waidley (gwaidley@engr.wisc.edu) at WHRP or John Cherney (john.cherney@dot.state.wi.us) at the WisDOT Library.

Review of Close-Range Photogrammetry Applications in Bridge Engineering
Paper No. 06-0563
Authors: Ruinian Jiang, David V. Jáuregui, Kenneth R. White
Abstract: Close-range photogrammetry has found many diverse applications in the fields of industry, biomechanics, chemistry, biology, archaeology, architecture, automotive, and aerospace, as well as accident reconstruction. Although close-range photogrammetry has not been as popular in bridge engineering as in other fields, the investigations that have been conducted demonstrate the potential of this technique. The availability of inexpensive, off-the-shelf digital cameras and softcopy, photogrammetry software systems has made close-range photogrammetry much more feasible and affordable for bridge engineering applications. To increase awareness of the use of this powerful non-contact, non-destructive technique in the bridge engineering field, this paper reviews the basic development of close-range photogrammetry and briefly describes previous work related to bridge deformation and geometry measurement; structural test monitoring; and historic documentation. The major aspects of photogrammetry bridge measurement are covered starting from the late 1970s and include a description of measurement types, cameras, targets, network control and software. It is shown that early applications featured the use of metric cameras (specially designed for photogrammetry purposes), diffuse targets (non-retroreflective), stereoscopic photogrammetry network layout, and analog analytical tools, which transformed over time to the use of non-metric cameras, retroreflective targets, highly convergent network layout, and digital computerized analytical tools.

Assessment of Post Tensioned Box Girder Bridges Applying Automated Non-destructive Testing Methods
Paper No. 06-1990
Authors: Doreen Streicher, Christoph Kohl, Herbert Wiggenhauser, Johannes Petz,
Abstract: Non-destructive testing (NDT) allows reducing of destructive testing and extends the possibilities for the assessment of concrete bridges. During the past years NDT methods in civil engineering have experienced broader public awareness and their performance was strongly improved. In this contribution results gained during the investigation of the inner structure of post tensioned box girder webs with impulse radar, ultrasonic echo and impact-echo will be presented. Two-dimensional measurements with these three NDT methods were carried out at two highway bridges in Vienna. A scanning system, developed at BAM (Federal Institute for Materials Research and Testing), was used at large areas and allowed automated data acquisition. The main objectives were the demonstration of the performance of radar, impact-echo and ultrasonic echo methods in automated measurements and the application of new tools for data processing and data visualization. By the combined application of the acoustic and electromagnetic impulse-echo methods tendon ducts could be localized at measurement depths up to 40 cm. The reinforcement on the outer side of the webs could be clearly visualized. Information about the position of tendon duct couplings and hints to ranges of incomplete grouted tendon ducts can be given. The investigations have also shown that further research is still necessary concerning the detection of grouting faults with the acoustic methods.

Bridge Deck Reinforcing Steel Cover Depth Prediction Using GPR
Paper No. 06-1904
Authors: Imad L. Al-Qadi, Kun Jiang, Samer Lahouar
Abstract: With increasing traffic volume on the Dan Ryan Expressway (I-90/94) bridge in Chicago, early detection and quantification of possible internal flaws and deterioration is needed. Using a reliable

measurement tool, informed decisions can be made about appropriate and timely repair and rehabilitation actions. In this study, six lanes, with nine sections each, of the Dan Ryan bridge deck were tested using ground penetrating radar (GPR). An image processing technique of the GPR data was then used to detect the reinforcing bars (rebar) and to estimate their cover depth profile. To estimate the cover depth profile, calculated concrete dielectric constants were utilized. The results of the analysis showed a variation of the rebar cover depth within and between the surveyed sections. The rebar cover depth of the surveyed lanes was mostly greater than 64mm (2.5in). The southbound middle lanes, #2, #3, and #4, had low cover depth, especially lane #3. This lane had a high percentage (44%) of a cover depth lower than 64mm (2.5in); 7% less than 50mm (2in). Locations determined to have extremely low rebar cover depth, less than 38mm (1.5in), showed spalling. The results of the GPR analysis were verified using limited ground truth cover depth measurements. The variation in the cover depth profile could be caused by rebar floating during construction.

Field Air Permeability Testing in Non-Destructive Condition Assessment of Damaged Concrete Structures

Paper No. 06-1085

Author: Ufuk Dilek

Abstract: This article discusses the use of in-situ air permeability testing in evaluation of fire damage to a concrete structure. In-situ air permeability measurements were made on the surface of concrete members damaged by exposure to fire. Non-destructive in-situ field air permeability testing was effective in identifying damaged areas. The findings of the field air permeability testing were compared to the findings of a conventional non-destructive testing method, ultrasonic pulse velocity. The area of surface distress indicated by in-situ air permeability results was larger than the area of compromise indicated by conventional ultrasonic pulse velocity testing. Field air permeability results were also compared to the laboratory testing results performed on core samples removed from the structure adjacent to field air permeability locations. Laboratory testing of samples enabled a comparison between field and laboratory air permeability data and enabled validation of field air permeability results. Air Permeability Index (API) of 25 mm (1 in.) thick disks sawed from the cores was determined in the laboratory testing phase. A significant increase in API was detected in the damaged areas and API was found to be particularly sensitive to fire damage. Air permeability index results indicated significant potential for further use as a quantifiable laboratory test method. The study also demonstrated the applicability of field air permeability as a rapid field indicator of sustained damage to concrete and associated drying and cracking due to exposure to elevated temperatures.